(12) UK Patent Application (19) GB (11) 2 298 835 (13) A

(43) Date of A Publication 18.09.1996

(21) Application No 9603130.7

(22) Date of Filing 15.02.1996

(30) Priority Data
(31) 07056264 (32) 15.03.1995 (33) JP
07056265 15.03.1995

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(51) INT CL[6]
G09B 9/058

(52) UK CL (Edition O)
B7H HQA

(56) Documents Cited
WO 94/19784 A1 WO 93/24915 A1 WO 92/16267 A
US 5415550 A
Commercial Motor (Vol 182, No 4606, 9-15 Feb 1995)
Truck Driving Simulator pages 14 & 15

(58) Field of Search
UK CL (Edition O) B7H HQA
INT CL[6] G09B 9/04 9/042 9/05 9/058

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(54) Apparatus for simulating running of vehicle

(57) An apparatus for simulating the running of a vehicle comprises a simulated vehicle body 1 capable of movement in response to driver inputs, a monitor 20 displaying the overall running environment, and means for selecting from memory and editing the data of various environmental factors such as road surface and climatic conditions to construct a preferred overall running environment. A driver R who is riding on the simulated motorcycle vehicle body 1 performs a driving operation of the simulated vehicle body 1 while looking at the overall running environment which is displayed on the monitor 20. The movements of the simulated vehicle body 1 are controlled based on the driving operation.

FIG.1

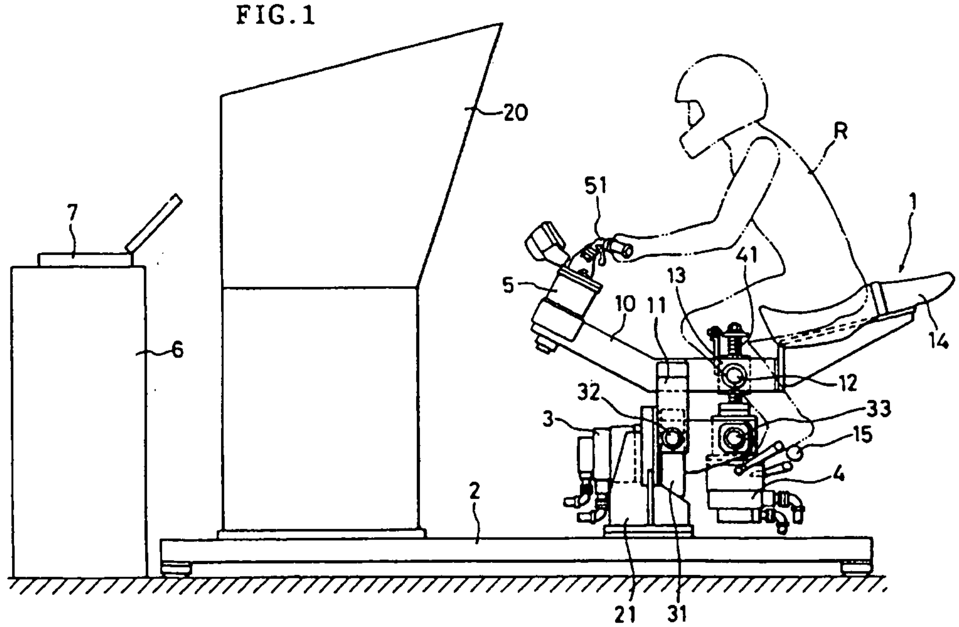

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FIG.1

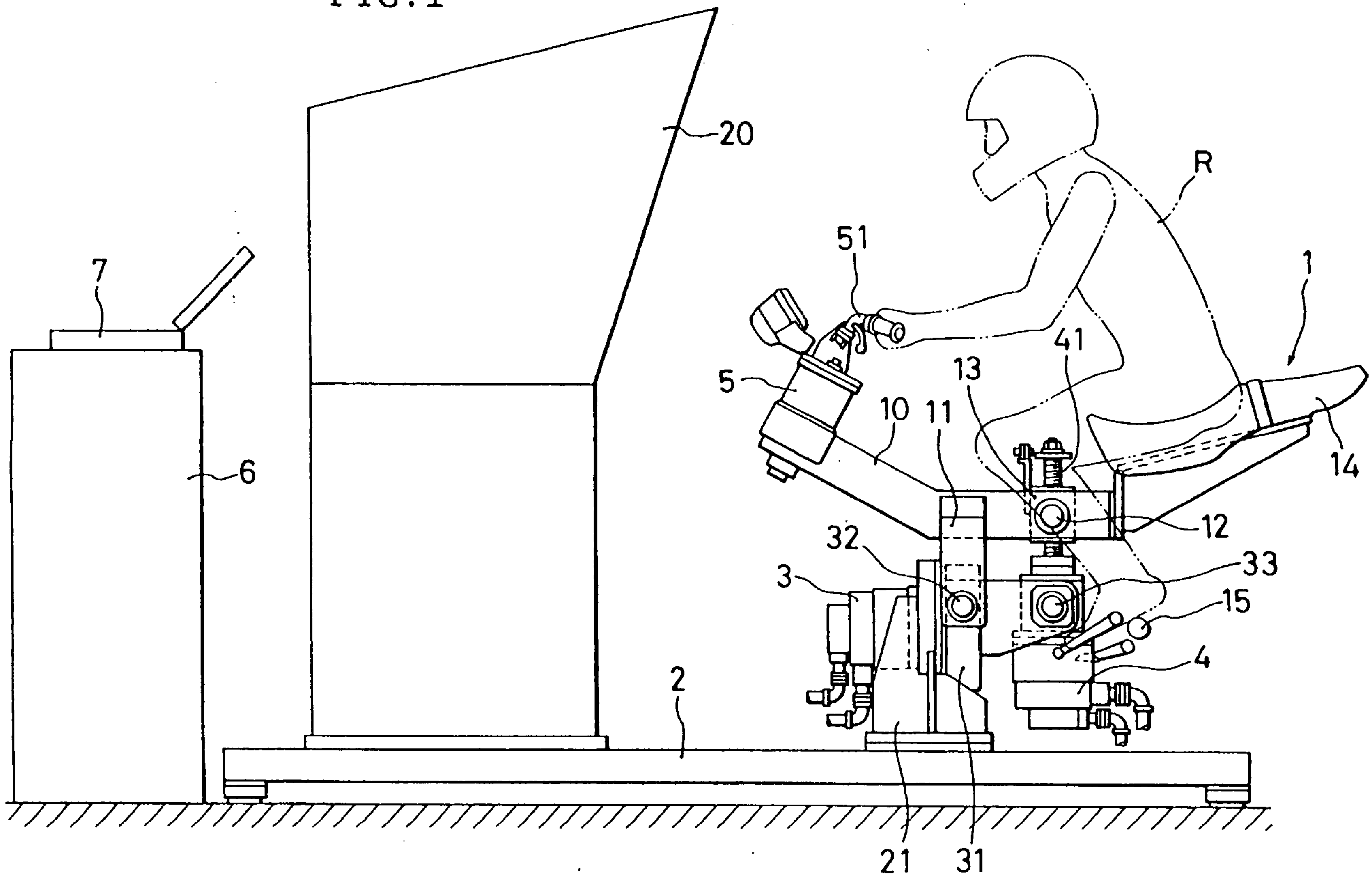


FIG.2

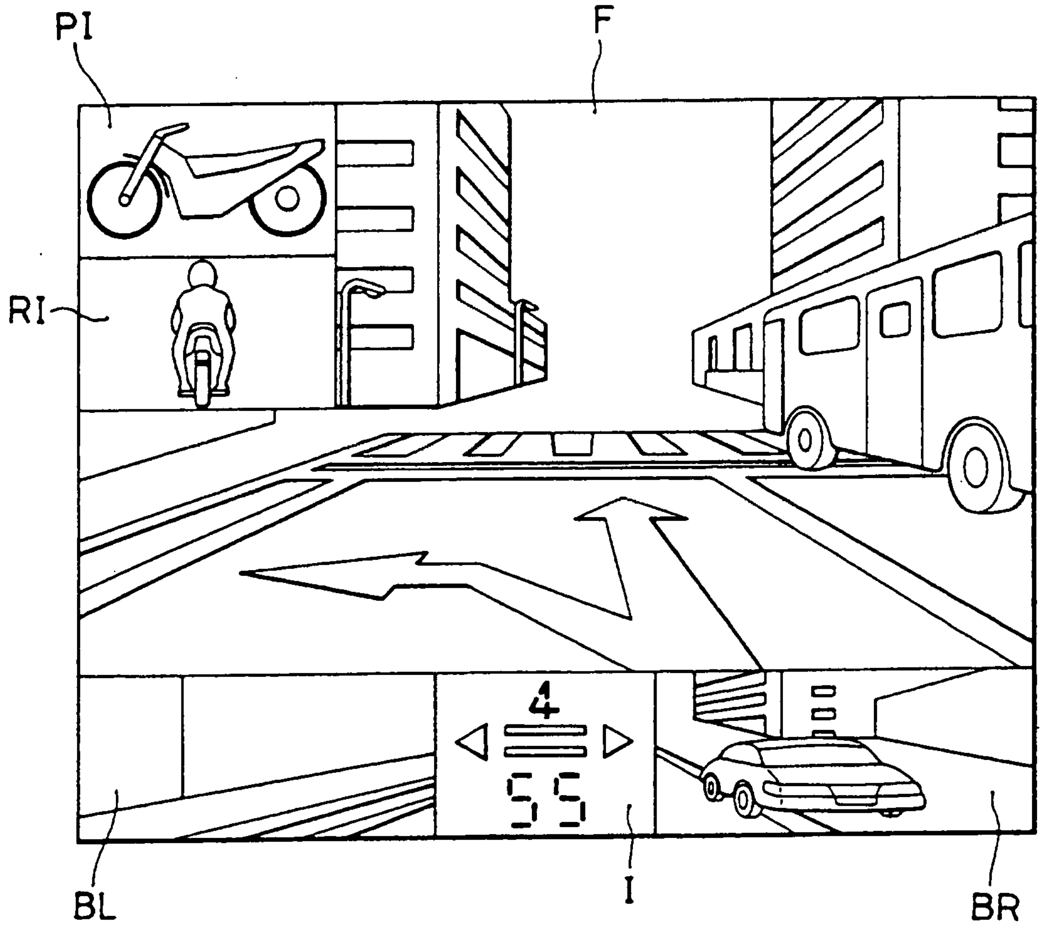


FIG.3

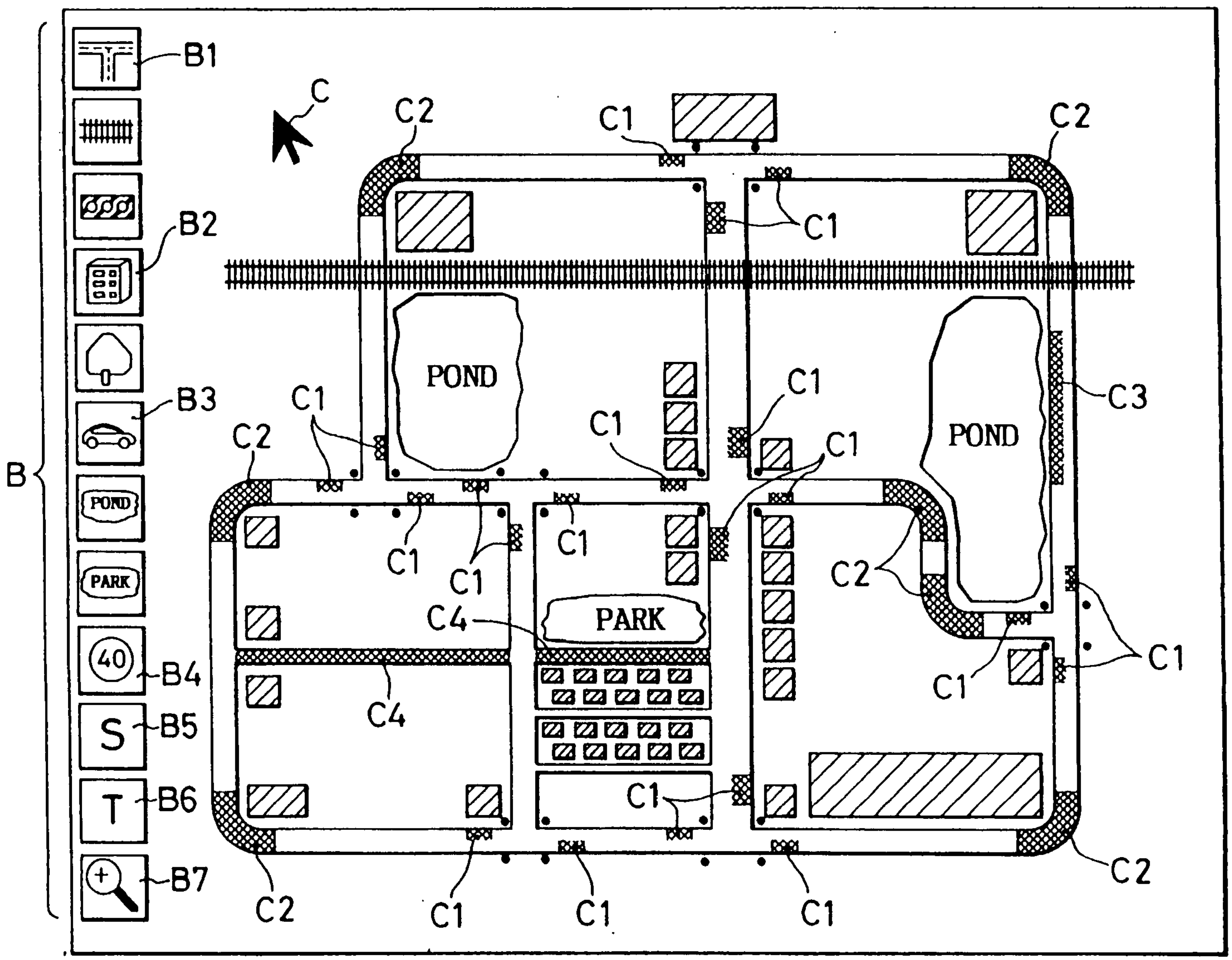
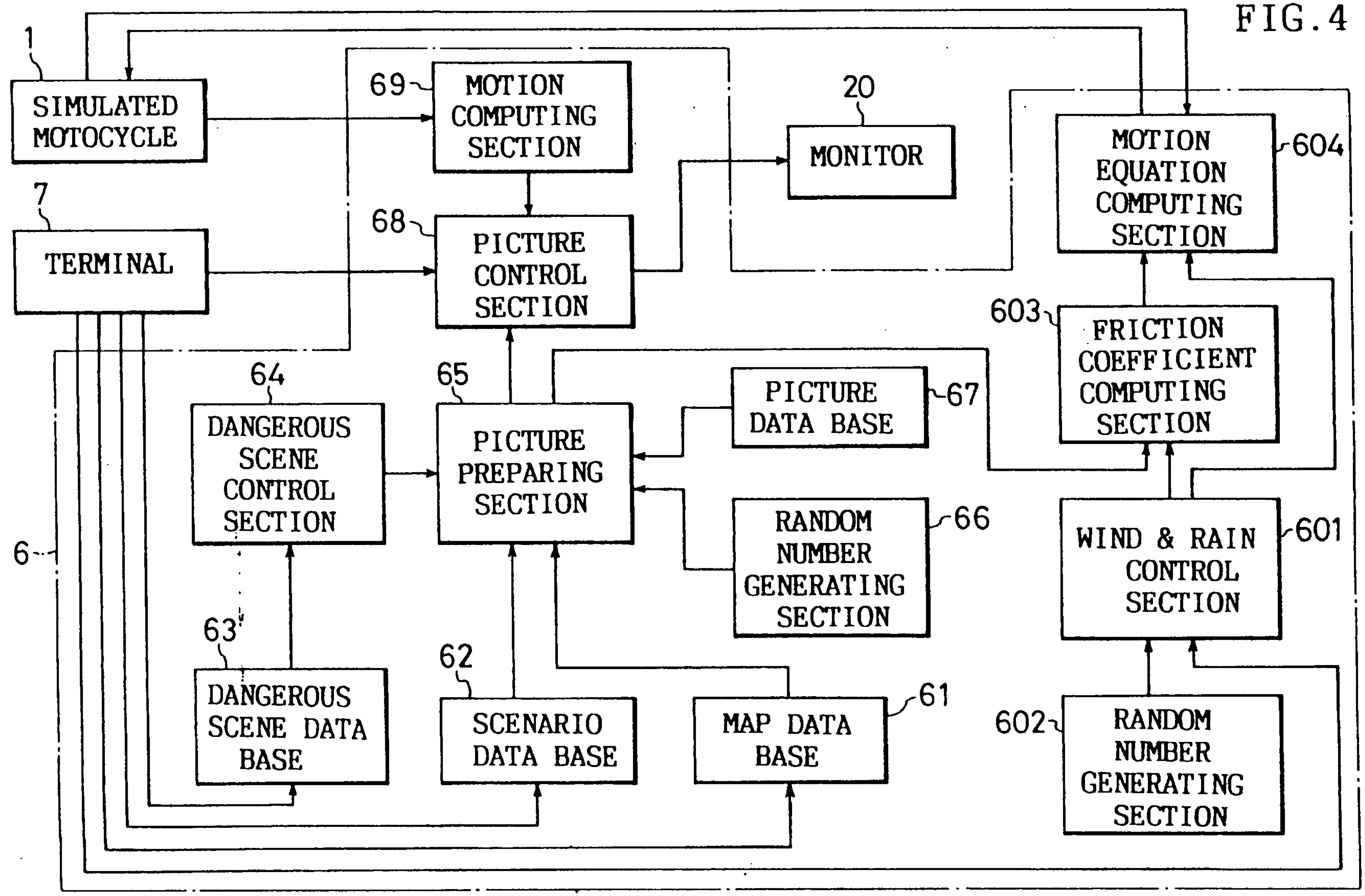


FIG. 4


1
SIMULATED MOTOCYCLE
7
TERMINAL
69
MOTION COMPUTING SECTION
68
PICTURE CONTROL SECTION
20
MONITOR
64
DANGEROUS SCENE CONTROL SECTION
65
PICTURE PREPARING SECTION
PICTURE DATA BASE
67
RANDOM NUMBER GENERATING SECTION
66
63
DANGEROUS SCENE DATA BASE
62
SCENARIO DATA BASE
MAP DATA BASE
61
6
MOTION EQUATION COMPUTING SECTION
604
603
FRICTION COEFFICIENT COMPUTING SECTION
WIND & RAIN CONTROL SECTION
601
602
RANDOM NUMBER GENERATING SECTION

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APPARATUS FOR SIMULATING RUNNING OF VEHICLE

The present invention relates to an apparatus for simulating running of a vehicle, the apparats having a simulated vehicle body and a monitor for displaying surrounding conditions in which the vehicle runs (hereinafter called "running surroundings").

In this kind of conventional apparatus for simulating running of a vehicle, the following arrangement is employed. Namely, a driver who is riding on a simulated vehicle body performs a driving operation of the simulated vehicle body while looking at the running surroundings which are displayed on a monitor, and the movements of the simulated vehicle body are controlled based on this driving operation, whereby the driver feels as if he were actually driving a vehicle on a road.

The actual running surroundings variously change depending on respective circumstances of plural kinds of surrounding factors such as a running course, the movements of the other vehicles, road surface conditions, climatic conditions, or the like. The running surroundings to be displayed on the monitor are conventionally constructed individually by a programmer based on his assumption of each of the surrounding factors. In order to bring the running surroundings as close to the actual state of things as possible, a large number of surrounding factors must be taken into consideration. Since it takes much time to construct even one running surrounding, it is difficult to prepare various running surroundings. Further, even if various running surroundings may have been constructed, a memory device to store these running surroundings becomes large in capacity, resulting in a higher cost. Therefore, the conventional apparatus is limited to the preparation of limited running surroundings of several patterns. As a

consequence, once the driver of the apparatus has experienced the driving or operation of the simulated vehicle body for certain times, he will memorize the running surroundings and will therefore be able to anticipate, during the operation, the running surroundings to be displayed next. Therefore, there is a disadvantage in that, when the apparatus for simulating the running of a vehicle is used for training the driving techniques, the training effects cannot be attained.

Further, when the apparatus for simulating the running of a vehicle is used for the purpose of training the driving techniques or the like, it is desirable to correct the running surroundings depending on the personality or the driving technique of each driver in order to increase the training effects. However, in case the running surroundings are constructed one by one as described above, it is impossible to correct the running surroundings on the spot.

In view of the above points, the present invention seeks to provide an apparatus for simulating running of a vehicle in which various running surroundings can be edited without using a large-scale memory device and in which the running surroundings can be freely corrected.

According to the present invention, the present invention is an apparatus for simulating running of a vehicle having a simulated vehicle body and a monitor for displaying running surroundings so that movements of the simulated vehicle body are controlled based on a driving operation to be performed by a driver who is riding on the simulated vehicle body while looking at the running surroundings to be displayed on the monitor, the apparatus comprising: memory means for memorizing a plurality of data which are set for each of plural kinds of surrounding factors constituting the running surroundings, the memorizing being made for each of the surrounding factors;

selecting means for selecting desired data out of the plurality of data for each of the surrounding factors; and editing means for editing overall running surroundings by reading out selected data of each of the surrounding factors as selected by the selecting means.

According to the present invention, by performing editing work by combining respective conditions of plural kinds of surrounding factors, it is possible to easily construct various running surroundings and also to freely correct the running surroundings by changing any of the surrounding factors. Further, the overall running surroundings are obtained by editing and, therefore, it is not necessary to individually memorize various running surroundings. It follows that a large-scale memory device becomes needless, resulting in a reduction in cost.

By the way, in the actual running of the vehicle, there are cases where the slippage is likely to occur depending on the road surface conditions. In this case, if there is provided correction means for correcting movements of the simulated vehicle body based on data on road surface conditions which are included in the running surroundings, it becomes possible for the rider to actually experience the movements on the slippery road surfaces. The rider can therefore effectively attain a driving technique for safely driving the vehicle on the slippery road surfaces. Further, the degree of slipping varies with the climatic conditions. Therefore, it is preferable to provide the apparatus with computing means for computing a coefficient of friction of a road surface based on data on climatic conditions and on the data on road surface conditions, both data being included in the running surroundings, so that the movements of the simulated vehicle body can be corrected depending on the computed coefficient of friction.

The above and other objects and the attendant

advantages of the present invention will become readily apparent by reference to the following detailed description when considered in conjunction with the accompanying drawings wherein:

Fig. 1 is a side view showing an arrangement of the apparatus for simulating running of a vehicle;

Fig. 2 is a diagram showing one example of a picture on a monitor 20;

Fig. 3 is a diagram showing one example of a picture on a terminal 7; and

Fig. 4 is a block diagram showing the arrangement inside a computing processor device.

By referring to Fig. 1, an explanation will now be made about an example of an apparatus for simulating running of a vehicle in the form of a motorcycle. Reference numeral 1 denotes a simulated motorcycle. When a driver R riding on the simulated motorcycle 1 performs a driving operation of the simulated motorcycle 1 while looking at running surroundings such as a landscape or the like to be displayed on a monitor 20 such as a CRT or the like which is disposed in front of the simulated motorcycle 1, the posture of the simulated motorcycle 1 is controlled depending on that operation. The simulated motorcycle 1 is provided with a frame-shaped skeleton body 10. An electric motor 3 for rolling movement (hereinafter called a "roll motor 3") is supported by a supporting frame 21 on a base 2 such that an axis of rotation becomes parallel with a longitudinal direction of the simulated motorcycle 1. A bracket 31 is mounted on a rotary shaft of the roll motor 3. On this bracket 31 there is provided a pivot 32, which is at right angles to the longitudinal direction of the simulated motorcycle 1, so as to project in the right and left directions. Lower ends of arms 11 which are vertically provided in a pair on the right and left sides of the skeleton body 10 are swingably supported

by the pivot 32. Further, on the bracket 31 there is provided a supporting shaft 33 which is parallel with the pivot 32, and an electric motor 4 for pitching movement (hereinafter called a "pitch motor 4") is provided in a manner to be swingable about the supporting shaft 33. On the other hand, the skeleton body 10 is provided with a nut 13 which is swingable about a supporting shaft 12 which is parallel with the supporting shaft 33. A threaded bar 41 which is connected to the pitch motor 4 is engaged with the nut 13 in a threaded manner. The simulated motorcycle 4 is thus subjected to a rolling movement by the roll motor 3 and is also subjected to a swinging, i.e., a pitching movement, by the pitch motor 4 about the pivot 32 relative to the bracket 31.

On the front end portion of the skeleton body 10 there is mounted a steering motor 5 at an inclination of a predetermined head angle. A handle 51 is directly connected to a rotary shaft of the steering motor 5. According to this arrangement, when the handle 51 is steered or rotated by the rider R, a predetermined load is given by the steering motor 5 against the rotation of the handle 51.

In this handle 51 there are contained various sensors for detecting the amount of operating an accelerator and the force of operating a front brake by the rider R. In a seat 14 there are mounted sensors for detecting the direction and amount of movement of the weight of the rider R. In steps 15 there are mounted sensors for detecting the change in load as a consequence of the movement of the weight of the rider R. In the neighborhood thereof, there are further provided sensors for detecting the force of operating a rear brake and the gear changing operation. The signals from these various sensors are processed by a computing processor device 6, and the roll motor 3, the pitch motor 4, and the steering

motor 5 are driven to thereby control the posture of the simulated motorcycle 1.

By the way, the picture or image on the monitor 20 is made up, as shown in Fig. 2, of a front view F, left rearward view BL, right rearward view BR, and running data I such as the running speed, gear shift information, or the like. There are also provided an indicating portion RI for indicating the rolling movement and an indicating portion PI for indicating the pitching movement of the simulated motorcycle 1. An ideal condition of the simulated motorcycle 1 and a condition of the simulated motorcycle 1 based on the driving operation by the rider R are doubly displayed, i.e., one on top of the other in these indicating portions RI, PI. The running surroundings to be displayed on the monitor 20 are to be edited by the operation of a terminal 7 of a computer or the like which is connected to the computing processor device 6. On the terminal 7 there is displayed a picture, for example, as shown in Fig. 3. It is thus possible to edit or change the running surroundings by appropriately selecting respective data of the various surrounding factors such as the course (or the route of travelling) or the like via the terminal 7.

The procedure of editing or changing this kind of running surroundings will now be explained with reference to Fig. 4. The terminal 7 is operated first to select map data which are stored in a map data base 61. In the map data base 61 there are stored various map data such as the streets, mountain paths, circuit racecourses, highways or the like. The picture shown in Fig. 2 is the one in which the map data on the streets are selected. Next, the terminal 7 is operated to select suitable scenario data out of a plurality of stored scenario data which are stored in a scenario data base 62 and define a running scenario, such as the course, the presence or absence of

other vehicles, or the like. Then, the terminal 7 is operated to select appropriate ones out of a plurality of stored dangerous scene data which define parameters stored in a dangerous scene data base 63, such as right-turning at an intersection of a vehicle running on the opposite lane, sudden stopping of a preceding vehicle, or the like. Data bases 61, 62, 63 correspond to memory means. By the way, in order to become familiar with the course for some period of time after the start of training the driving techniques, it is sometimes desirable to arrange that no dangerous scenes occur. In such a case, a signal is sent from the terminal 7 to a dangerous scenes control section 64 to edit such that no dangerous scenes occur. The map data and the scenario data selected as explained above and the dangerous scene data via the dangerous scene control section 64 are read into a picture preparing section 65. To the picture preparing section 65 there is connected a random number generating section 66 to thereby control the movements of the other vehicles and pedestrians based on random numbers. In order to display the running surroundings to be constructed by these surrounding factors on the monitor 20, they must be converted to pictures as viewed in the eyes of the rider R. Therefore, after the picture data such as the landscapes of the streets and the movements of the other vehicles and pedestrians in a picture data base 67 are called and synthesized in a form for displaying on the monitor 20, they are outputted to a picture control section 68 which serves as editing means. In turning a corner, for example, the simulated motorcycle 1 is tilted, but a centrifugal force will not occur in the simulated motorcycle 1. Therefore, it is desirable to tilt the picture to the direction opposite to the simulated motorcycle 1 to thereby give the rider R an illusion that the simulated motorcycle 1 were largely tilted, as well as

to change the feed speed of the picture in the monitor 20 depending on the running speed. As a solution, depending on the posture and the speed of the simulated motorcycle 1, picture correction signals from a motion computing section 69 are outputted to the picture control section 68. Picture signals corrected by the picture correction signals are thus outputted to the monitor 20 for displaying thereon.

The above-described various editing works and the correction of edited contents can be carried out in concrete on the screen as shown in Fig. 3. Namely, a curser C of a mouse (not illustrated) is moved over one of various item buttons B shown in a vertical array on the left side of the screen, and a push button of the mouse is clicked to thereby finish the setting in each item button. For example, in an item button B1 regarding roads a setting is made as to the width of the roads. In an item button B2 regarding buildings a setting is made as to the kinds of buildings to appear on the course. In an item button B3 regarding the other vehicles a setting is made as to whether the other vehicles such as those running on the opposite lane or the like are passenger cars, buses or trucks. In an item button B4 for signs a setting is made as to various signs such as speed-limit signs, no-parking signs or the like. In an item button B5 for scenario a setting is made as to whether or not there should occur such things as abrupt running of a pedestrian into the road, opening of a door of a parking vehicle, forcible overtaking of another vehicle or the like. In the Figure, reference B6 denotes an item button for setting a trigger area for the occurrence of dangers and reference B7 denotes an item button for zooming.

In this manner the running surroundings can be easily edited by the terminal 7. When the running surroundings once edited are to be corrected depending on

the driving technique of the rider R or the like, it is not necessary to newly edit the running surroundings but need to correct only the surrounding factors that require correction.

By the way, in the map data there are also contained data on the road surface conditions. In Fig. 3, reference C1 which is set around each intersection and reference C2 which is set in each corner denote so-called special pavement portions, where a coefficient of friction is set larger than on an ordinary road surface. Reference C3, on the other hand, denotes steel plates placed or spread on the road portion under repairs where a coefficient of friction is set smaller than on an ordinary road surface. Reference C4 denotes a gravel road where an arrangement is made such that the running becomes unstable because the front wheel cannot maintain a directional control and that an apparent coefficient of friction is made smaller than on an ordinary road surface. As another arrangement, the coefficient of friction on the painted portions such as the center lines and intersections is made smaller than on an ordinary road surface.

It is also arranged that climatic conditions can be selected by the terminal 7. When rainy or snowy and windy conditions are selected, a wind and rain control section 601 in the computing processor device 6 determines the strengths of the rain or snow and of the wind. In case the strengths of the rain and wind are to be automatically varied, the random numbers can be introduced from a random number generating section 602 to thereby vary the strengths of the rain and wind based on the random numbers. In case the strengths are to be varied manually, the strengths of the rain and wind are inputted from the terminal 7. Once the strengths of the rain and wind are determined in this manner, data on the strength of the rain or snow are outputted to a friction coefficient

computing section 603, and data on the strength of the wind are outputted to a motion equation computing section 604. The friction coefficient computing section 603 having inputted thereto the strength of the rain or snow reads out from the picture preparing section 65 data on the conditions of the surface of the road on which the simulated motorcycle 1 is now running. The coefficients of friction of the road surfaces are obtained based on the data on the rain or snow and the data on the road surface conditions. The motion equation computing section 604 reads in the signals detected by each of the above-described sensors on the simulated motorcycle 1 to thereby compute the posture of the simulated motorcycle 1 based on each of these detected signals, and further corrects the computed posture based on the data on the coefficients of friction and the above-described data on the strength of the wind. Based on the corrected computing results, each of the above-described electric motors 3, 4, 5 is controlled to thereby control the posture of the simulated motorcycle 1.

Therefore, the coefficients of friction are calculated to be easier to slip when the rain or snow is heavy, to be harder to slip, than the other portions, in C1 or C2 where the special pavement is applied to the road surface, and to be easier to slip, than the other portions, in C3 where steel plates are spread on the road surface. Depending on the coefficients of friction, the braking distance is changed and the degree of slipping at the time of applying the brake is changed. In accordance with the movements to occur in the actual running of the vehicle, the posture of the simulated motorcycle 1 and the picture on the monitor 20 are corrected. For example, a brake factor Kb is defined, as given as in the following formula (1), to be a function of the coefficient of friction Rμ and a rain factor Kr which is the strength of

the rain or snow.

$$Kb = R\mu / (Kr + 1) \quad \ldots \quad (1)$$

A braking force Bk is then obtained by the following formula (2) from the brake factor Kb to be defined by the above formula (1) and an operating force Bt to be applied to a brake lever or a brake pedal.

$$Bk = Bt \cdot Kb \quad \ldots \quad (2)$$

The braking distance or the like is changed accordingly. The change in the braking distance is expressed as the change in the stopping position in the picture on the monitor 20.

Further, when the wind is operating as a side wind, a correction is made such that the running direction becomes zigzag depending on the strength of the wind, taking into consideration the magnitude of the coefficient of friction.

In the above-described embodiment, an explanation has been made about an example of an apparatus for simulating running of a motorcycle. It can of course be applied to a simulating apparatus for automobiles or the like.

CLAIMS

1. An apparatus for simulating running of a vehicle having a simulated vehicle body and a monitor for displaying running surroundings so that movements of the simulated vehicle body are controlled based on a driving operation to be performed by a driver who is riding on the simulated vehicle body while looking at the running surroundings to be displayed on the monitor, said apparatus comprising:

memory means for memorizing a plurality of data which are set for each of plural kinds of surrounding factors constituting the running surroundings, said memorizing being made for each of said surrounding factors;

selecting means for selecting desired data out of said plurality of data for each of said surrounding factors; and

editing means for editing overall running surroundings by reading out selected data of each of said surrounding factors as selected by said selecting means.

2. An apparatus for simulating running of a vehicle according to claim 1, further comprising correction means for correcting movements of said simulated vehicle body based on data on road surface conditions which are included in said running surroundings.

3. An apparatus for simulating running of a vehicle according to claim 2, further comprising computing means for computing a coefficient of friction of a road surface based on data on climatic conditions and on said data on road surface conditions, both data being included in said running surroundings, wherein said correction means corrects the movements of said simulated vehicle body depending on said computed coefficient of friction.

4. An apparatus for simulating running of a vehicle as hereinbefore substantially described with reference to

the accompanying drawings.

The Patent Office

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Application No: GB 9603130.7
Claims searched: 1 to 4

Examiner: Robert Crowshaw
Date of search: 3 April 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): B7H (HQA)

Int Cl (Ed.6): G09B 9/04, 9/042, 9/05, 9/058

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	WO 94/19784 A	(ATARI) See especially the programmable simulation scenarios on pages 4 - 8.	
X	WO 93/24915 A	(ATARI) See especially the selection of environmental factors on page 20 lines 37 to page 21 line 18, and the vehicle movement on page 54 lines 29 to page 55 line 10, and page 63 lines 16 to page 64 line 20.	1
A	WO 92/16267 A	(ATARI) See especially the simulated vehicle movement on page 12 lines 4 - 37.	
X,P	US 5415550	(HONDA) See especially the selection of running modes in column 2 lines 22 - 46.	1
X	COMMERCIAL MOTOR (Vol 182, No 4606, 9-15 Feb 1995) See the 'Truck Driving Simulator' article on pages 14 & 15.		1, 2

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
&	Member of the same patent family		